

Topic 3

Uncertainties and Data Limitations for Management of Hydrometeorological Extremes



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DOE Water Cycle Workshop Sept 24-26 , 2012

Predictability and Uncertainty

Measurements and Observations

Mapping Processes **Unambiguously**

----Rainfall Intensity and Rainfall Extremes

Water Budgets, Functional Regimes and Hydrologic Extremes

-- Location, Location, Location

-- Nonlinearity

-- Nonstationarity and Change

Model (Multiscale) Challenges

Downscaling - Challenge or Fallacy?

Prediction vs Projection

--Atmosphere: Interannual Variability

Boundary Layer Dynamics

Land-Atmosphere Coupling and Instability

Topography

--Land: Forcing Intermittency

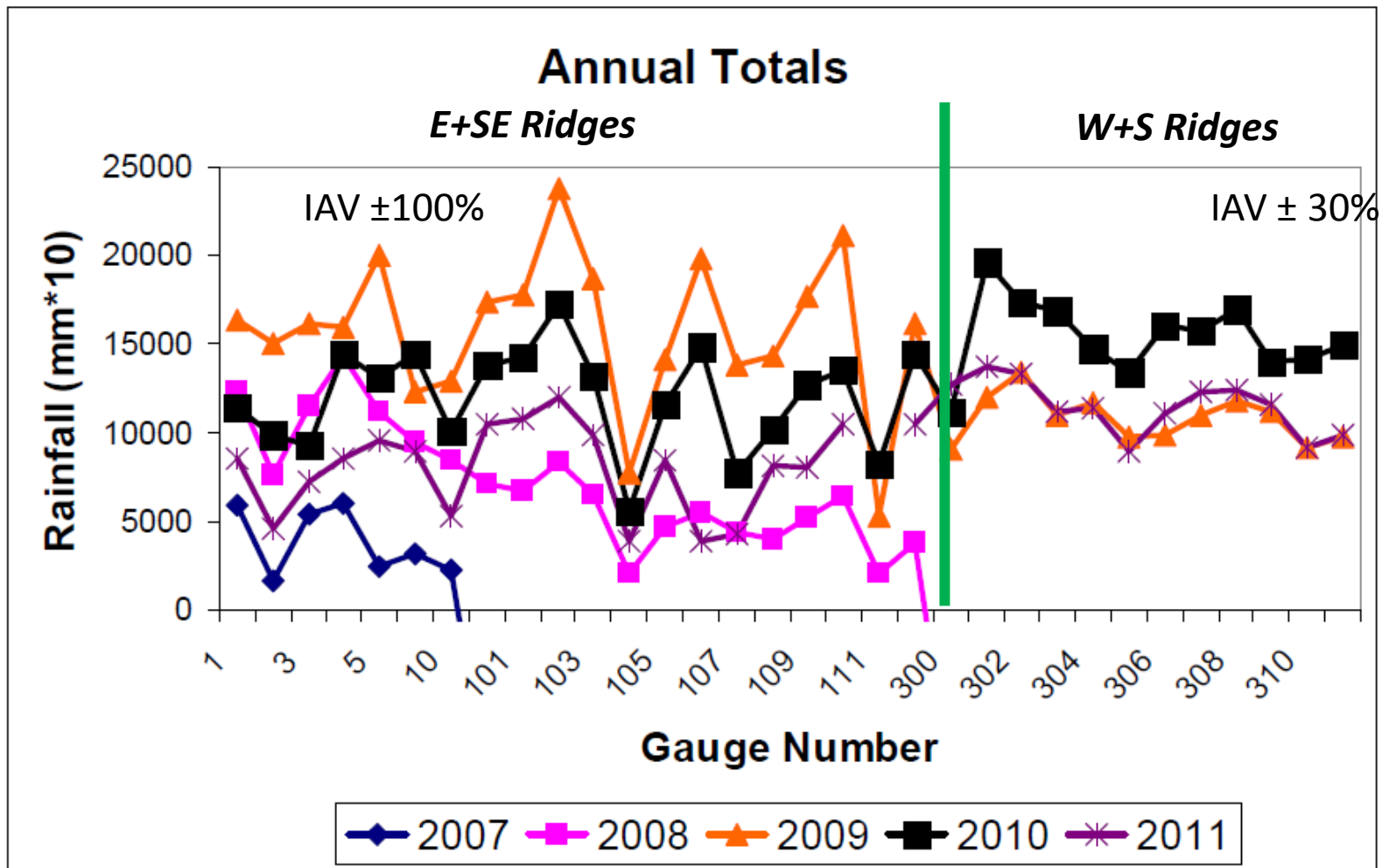
Pathways

Fluxes

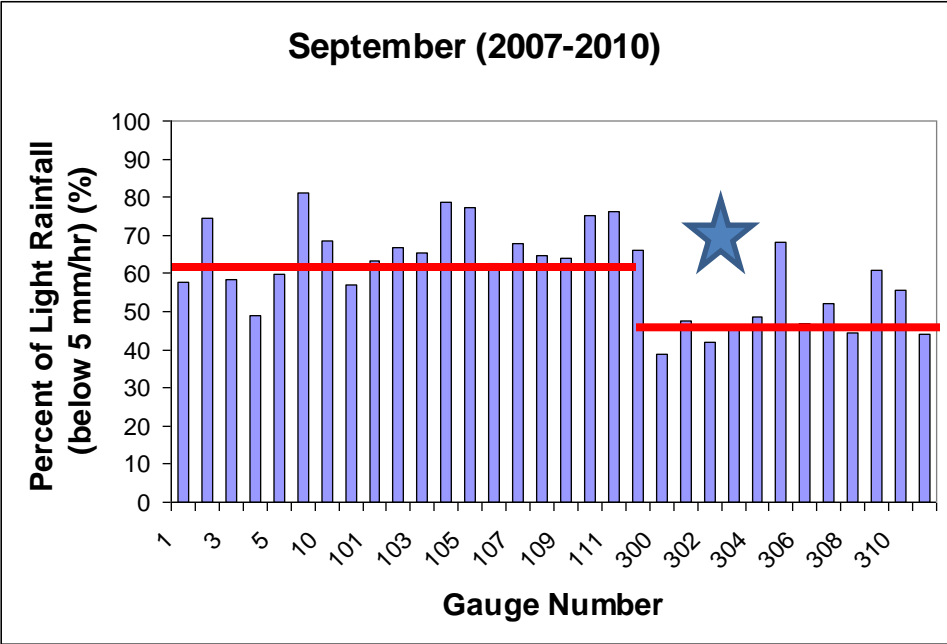
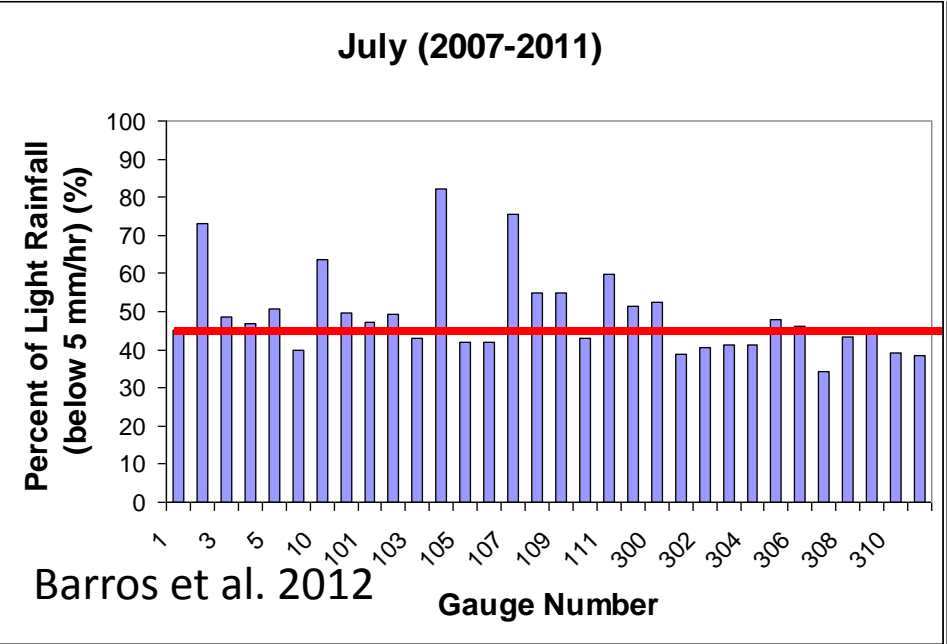
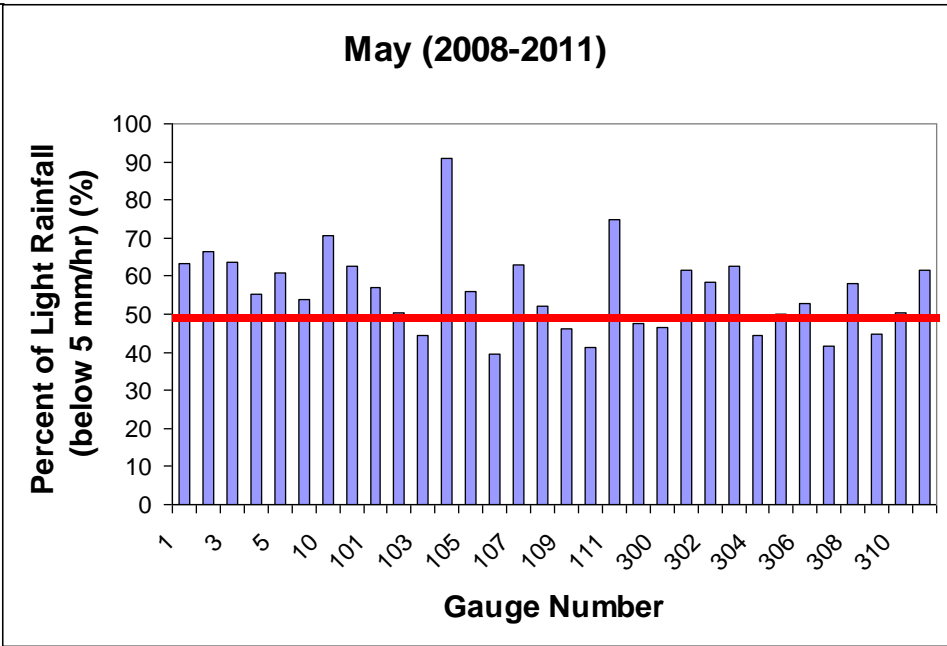
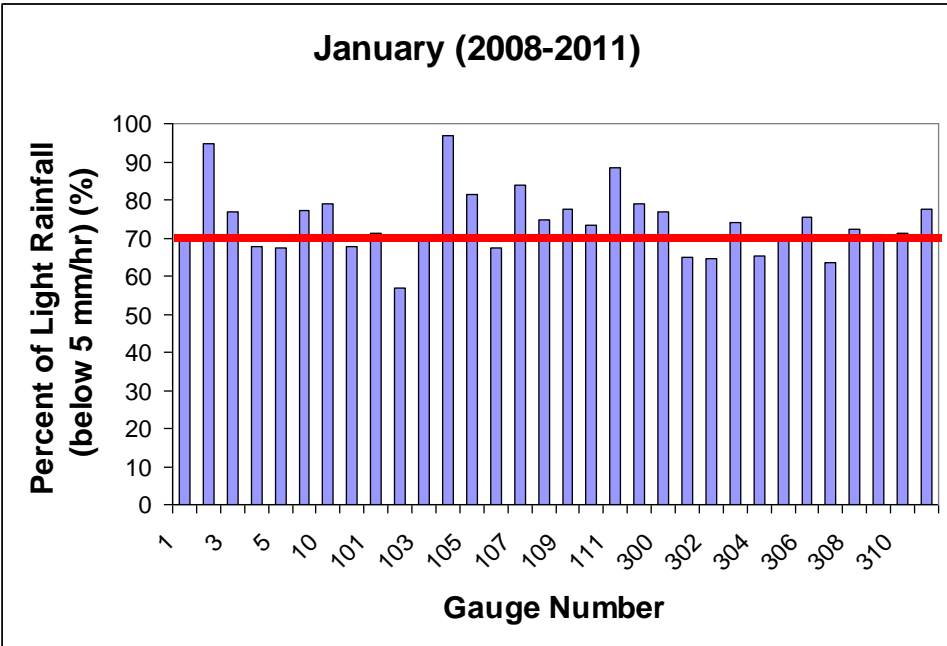
Vegetation and ET

Appalachians

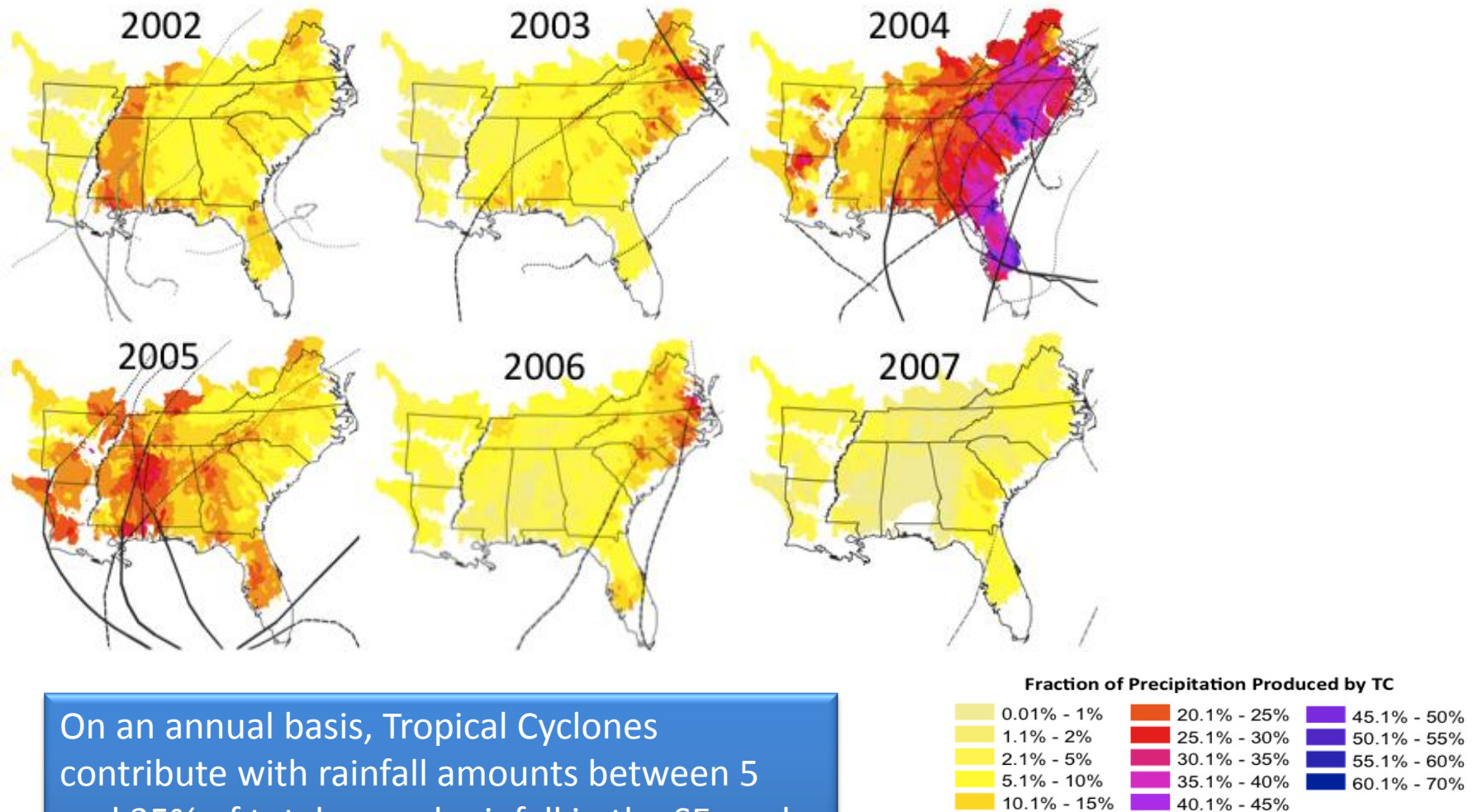
Light Rainfall is key to Landscape Resilience in the Context of Very Large Interannual Variability



Seasonal Variability of Light Rainfall

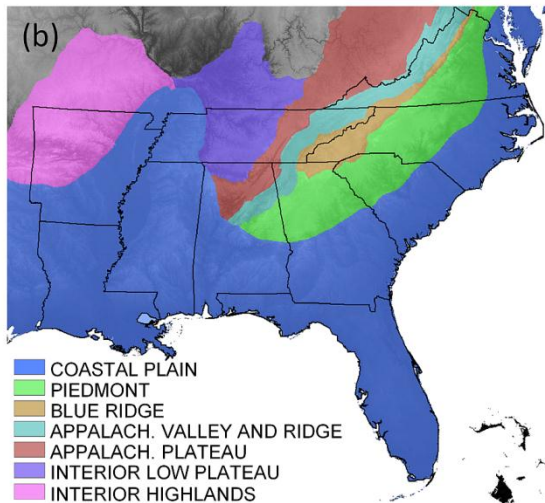
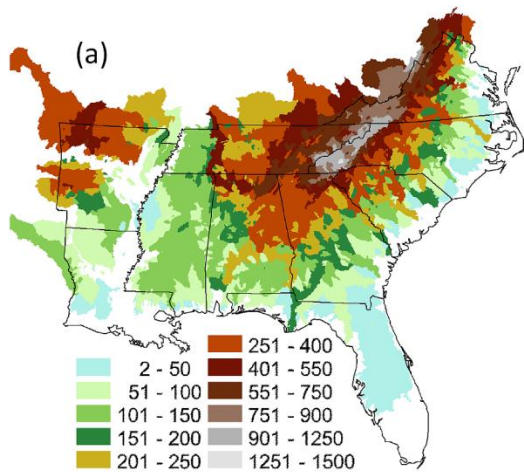


Fraction of Annual Precipitation Contributed by Hurricane Season Tropical Cyclone Activity



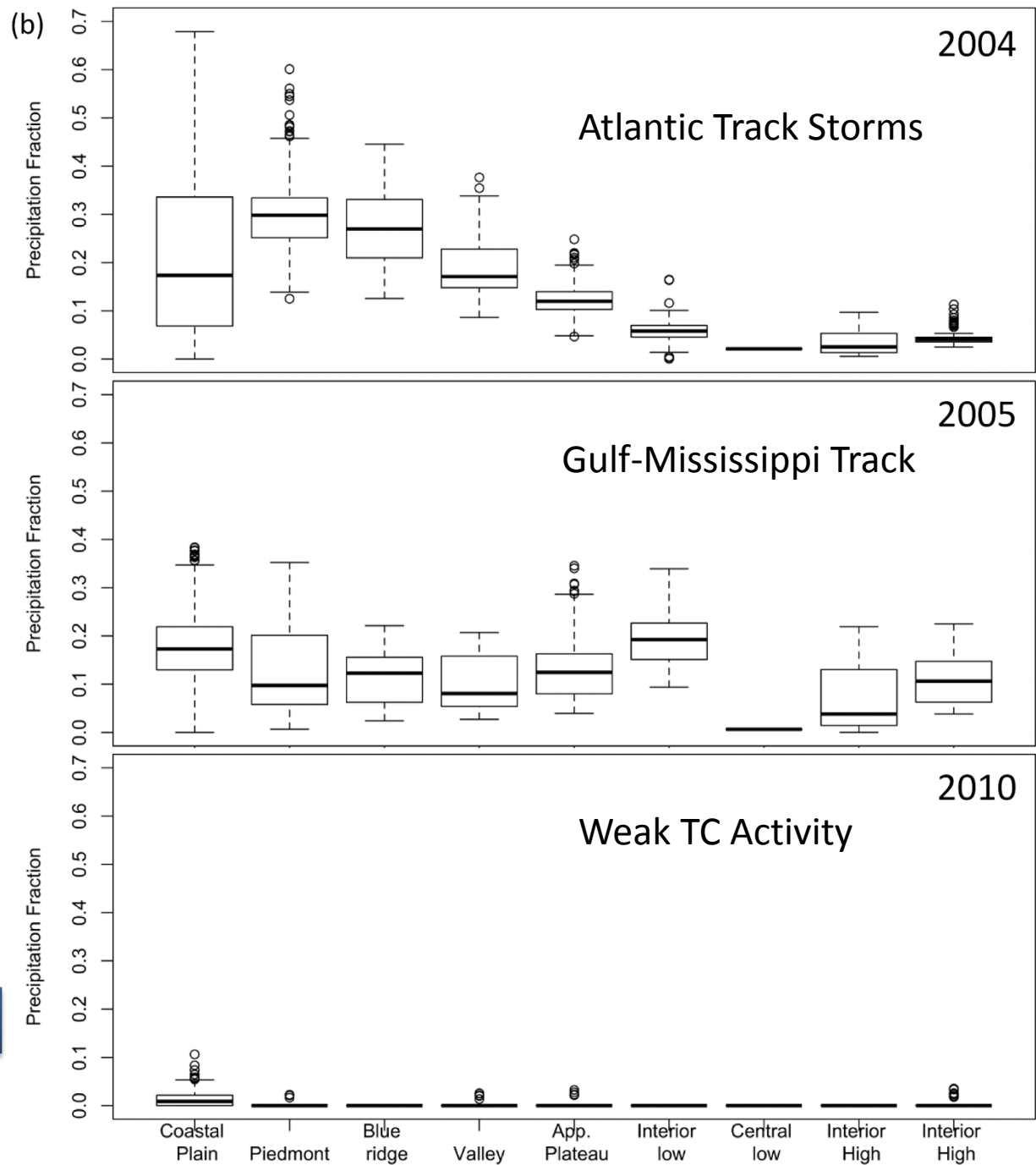
On an annual basis, Tropical Cyclones contribute with rainfall amounts between 5 and 35% of total annual rainfall in the SE, and in years with high activity such as 2004 that contribution can be as high as 70% in some basins.

Brun and Barros, 2012



Interannual Spatial Variability

Brun and Barros, 2012



Outliers for 10-year Flood Event using moving 20 year windows records to assess 20th century nonstationarity

Barros and Duan, 2012

Note alignment of outliers with major/growing urban areas

Outlier (10Year)

- 1990-2010
- 1980-2000
- 1970-1990
- 1950-1970

Stream Gauges

- 1900-2010

Outlier (10Year)

- 1990-2010
- 1980-2000
- 1970-1990
- 1960-1980
- 1950-1970
- 1940-1960
- 1930-1950
- 1920-1940

Stream Gauges

- 1920-2010

Outlier (10Year)

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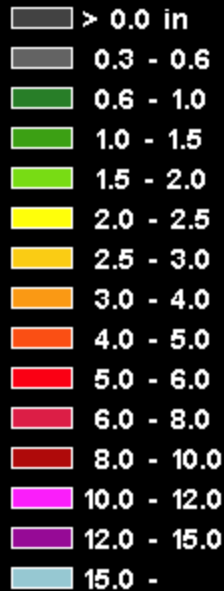
- 1980-2010

08:53 EDT
09/30/10



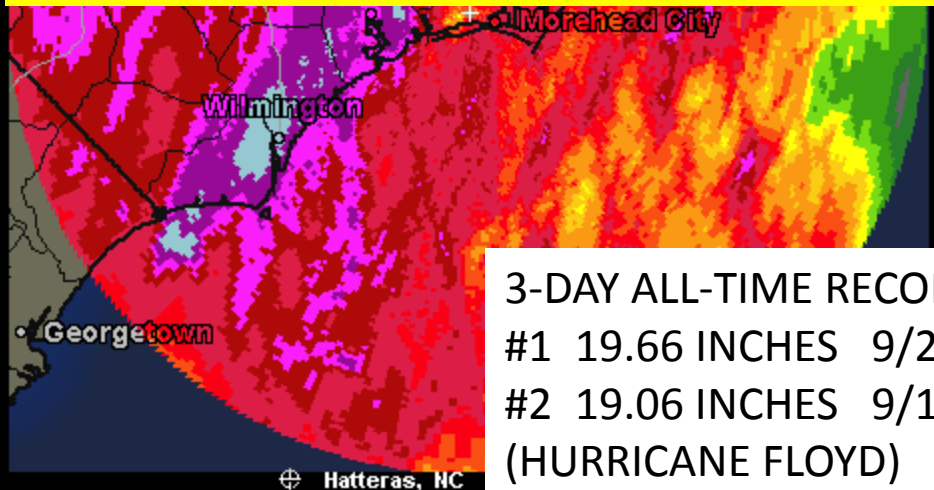
12:53 UTC
09/30/10

Max rainfall (in) 18.9
Begin date Sep 25



SEPTEMBER MONTHLY RAINFALL RECORDS...

- #1 23.41 INCHES 1999 (HURRICANES DENNIS & FLOYD)
- #2 20.84 INCHES 2010 (ONGOING EVENT THROUGH 720 AM...)
- #3 20.10 INCHES 1877 ("HURRICANE FOUR")
- #4 18.94 INCHES 1984 (HURRICANE DIANA)
- #5 16.93 INCHES 1924 ("HURRICANE FIVE" AND "TROP STORM EIGH



3-DAY ALL-TIME RECORDS... (September)

- #1 19.66 INCHES 9/27 - 9/29 2010
- #2 19.06 INCHES 9/14 - 9/16 1999 (HURRICANE FLOYD)
- #3 17.71 INCHES 9/15 - 9/17 1999 (HURRICANE FLOYD)
- #4 14.73 INCHES 9/13 - 9/15 1999 (HURRICANE FLOYD)
- #5 13.44 INCHES 9/11 - 9/13 1984 (HURRICANE DIANA)

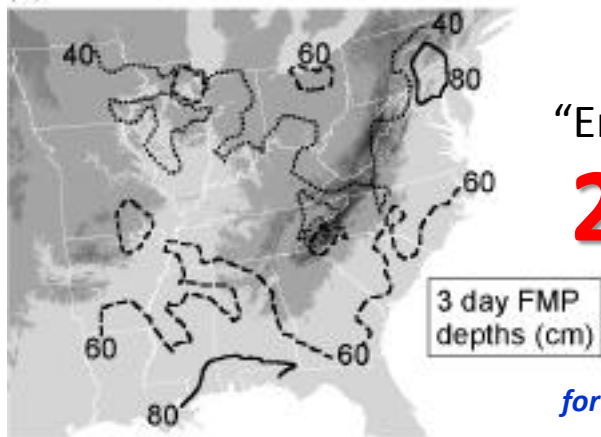
~ 20"

Tropical Storm Nicole

What is the maximum rainfall?
(not necessarily leading to flooding)

raingauge data: 1950-1997

(a)

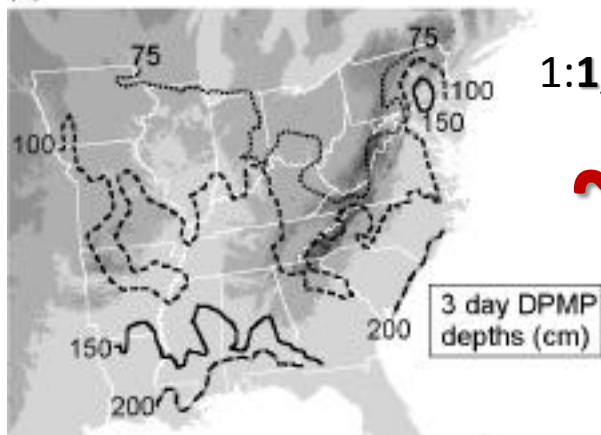


“Empirical” Maximum
23” – 31”

for any 3-day event at a point

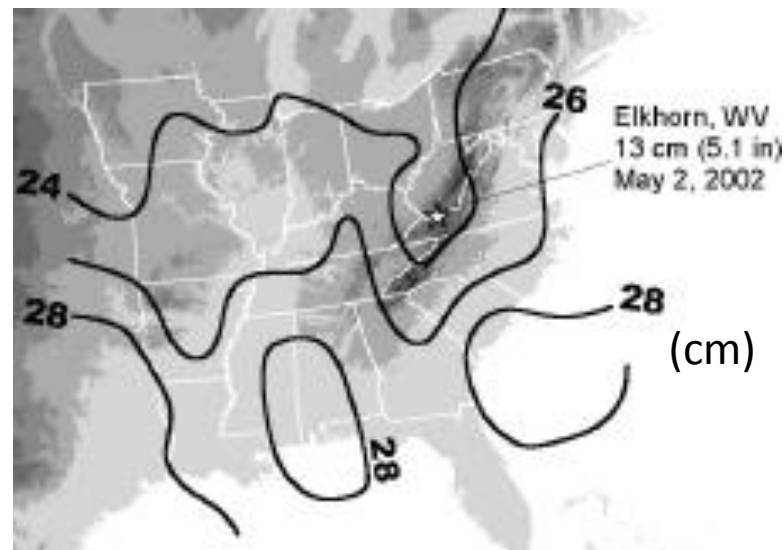
From NCEP-NCAR Reanalysis
6-hourly Maximum 1950-1997
Precipitable Water Flux

(b)



1:1,000 000 year event

~78”



Note: using data before Floyd

Douglas and Barros, 2002 JHM

A 10% increase in PWAT >>>> still within FMP

So what does it mean for the floods?

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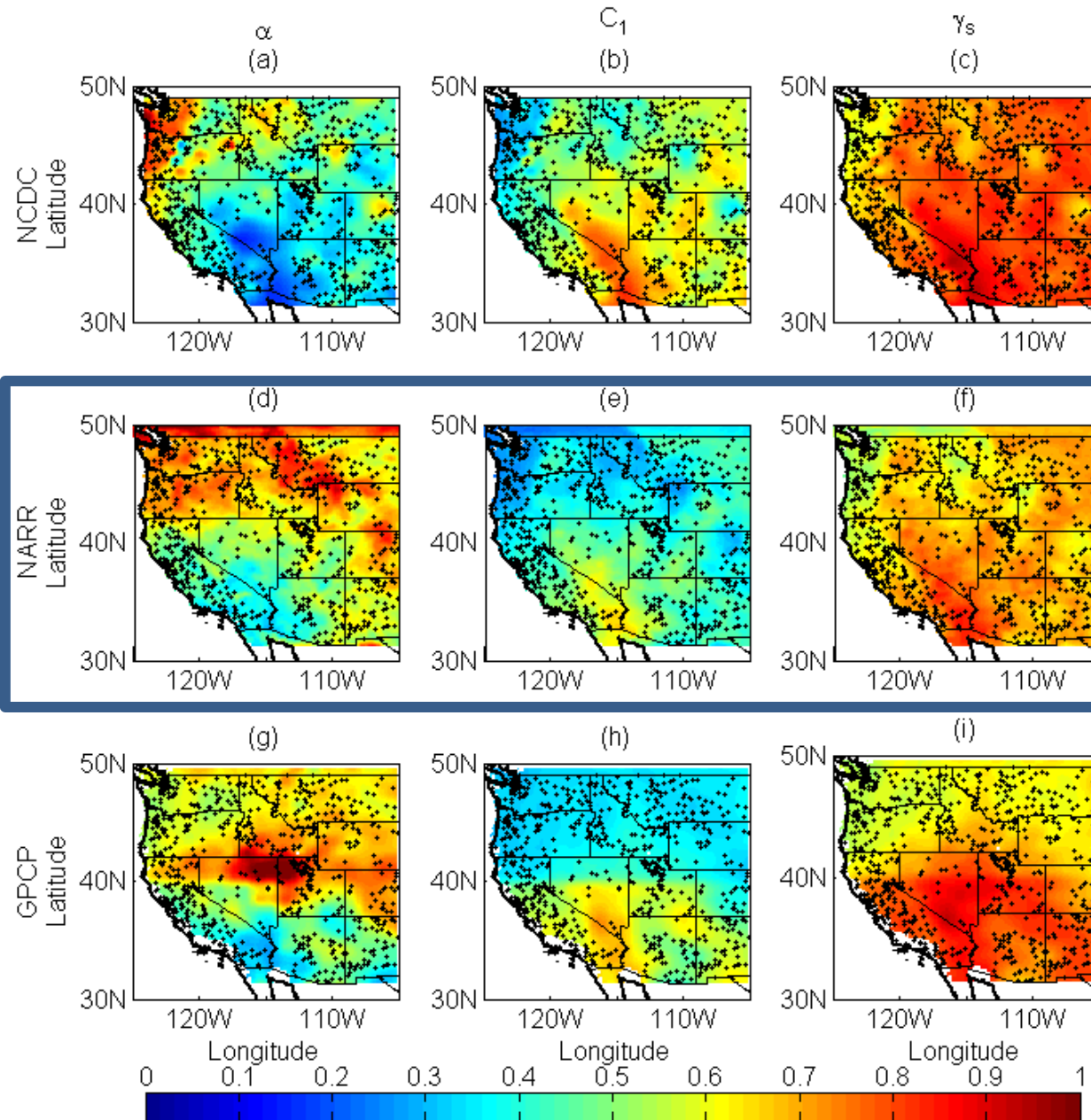
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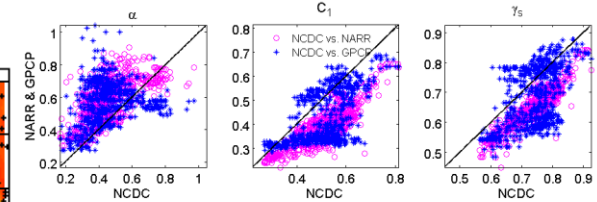
Fluxes

Vegetation and ET

On the true character of extreme rainfall



Multifractal Statistics



Model vs Observations

Lower frequency of
“large” amplitude variations

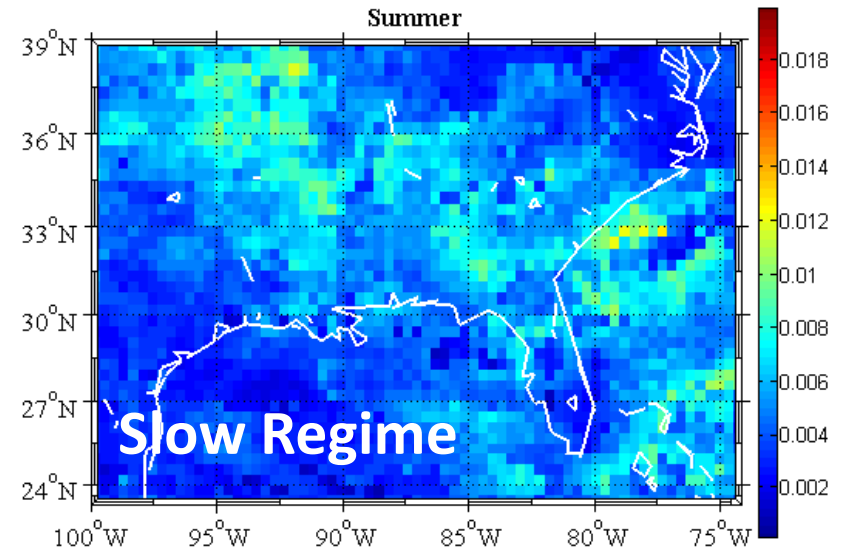
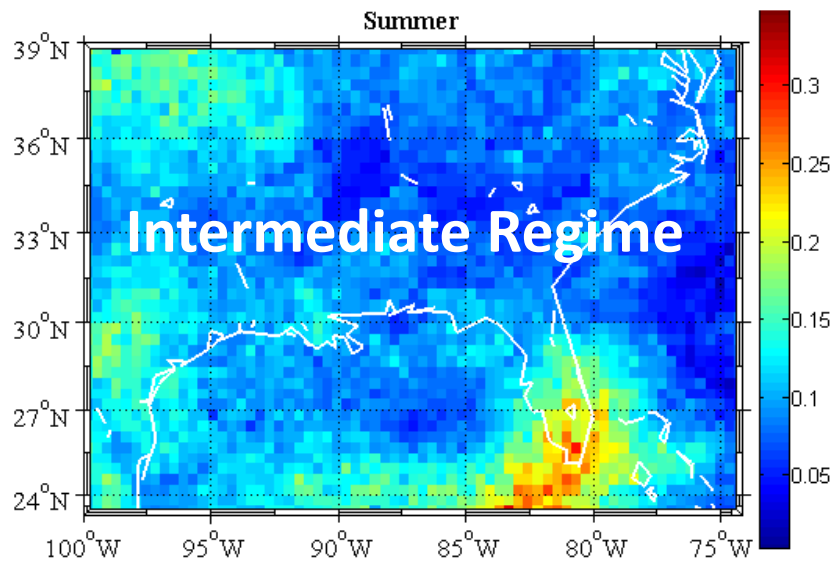
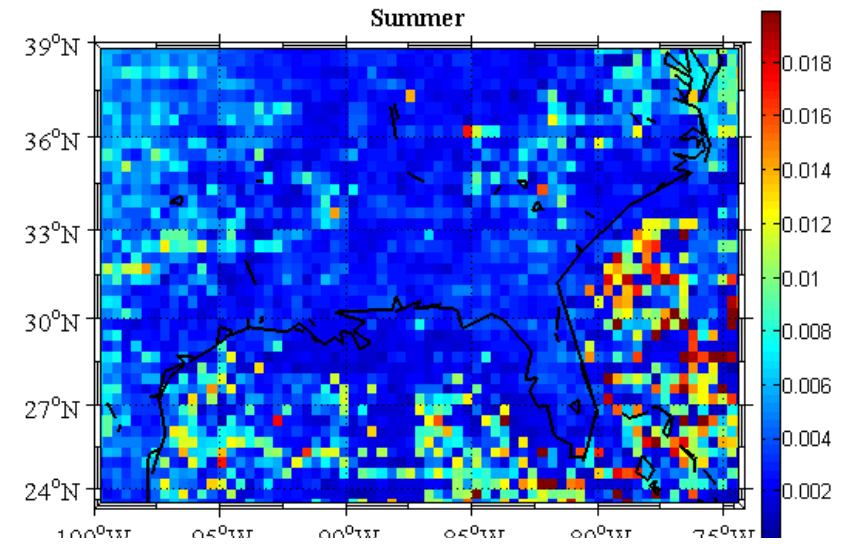
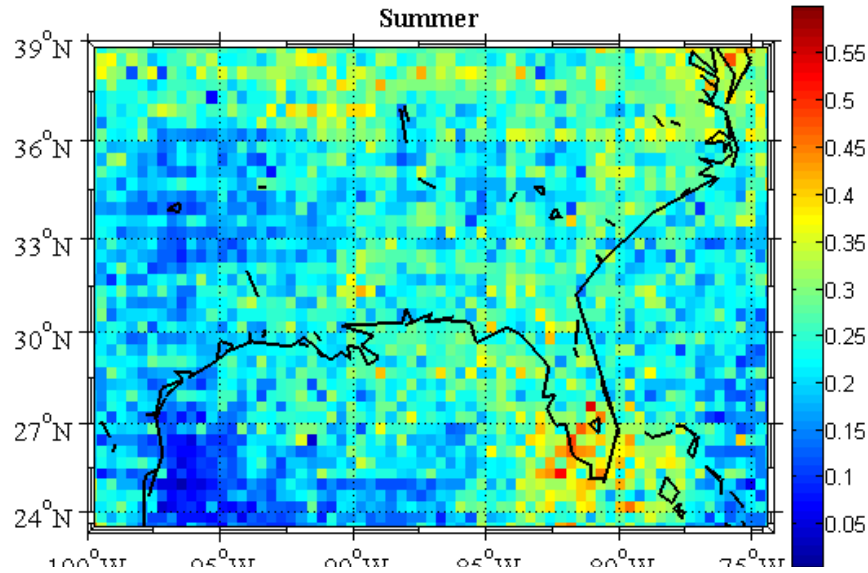
Smaller amplitudes

Smaller magnitude of
extreme value (PMP)

Representation of Land-Atmosphere Coupling

NARR

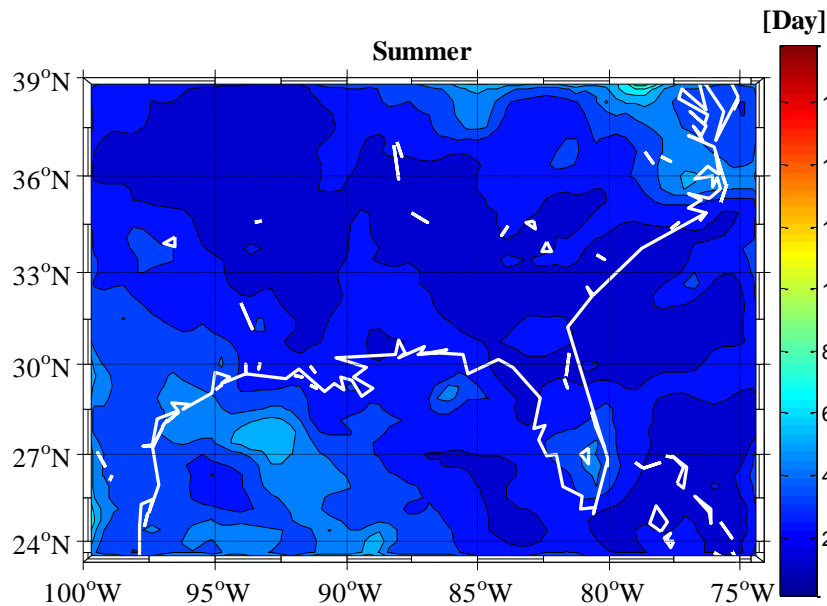
ISCCP data



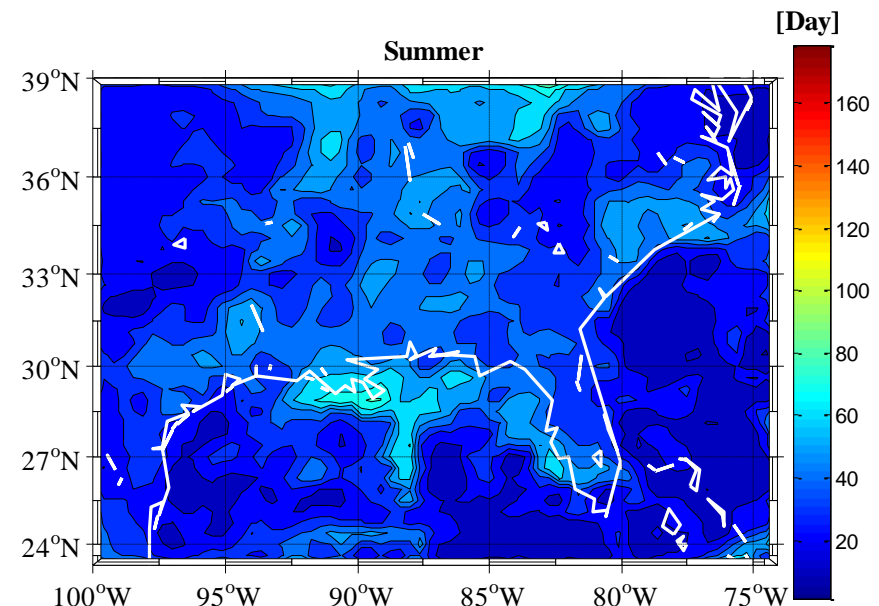
Tao and Barros, JGR, 2010 and Barros, 2011

Memory of Large-Scale Perturbations

Land-Atmosphere coupling is “too” strong in models implying short memory than in observations . This has implications for the (poor) predictability of summer drought persistence the SE.



NARR

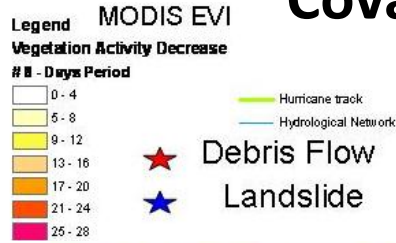


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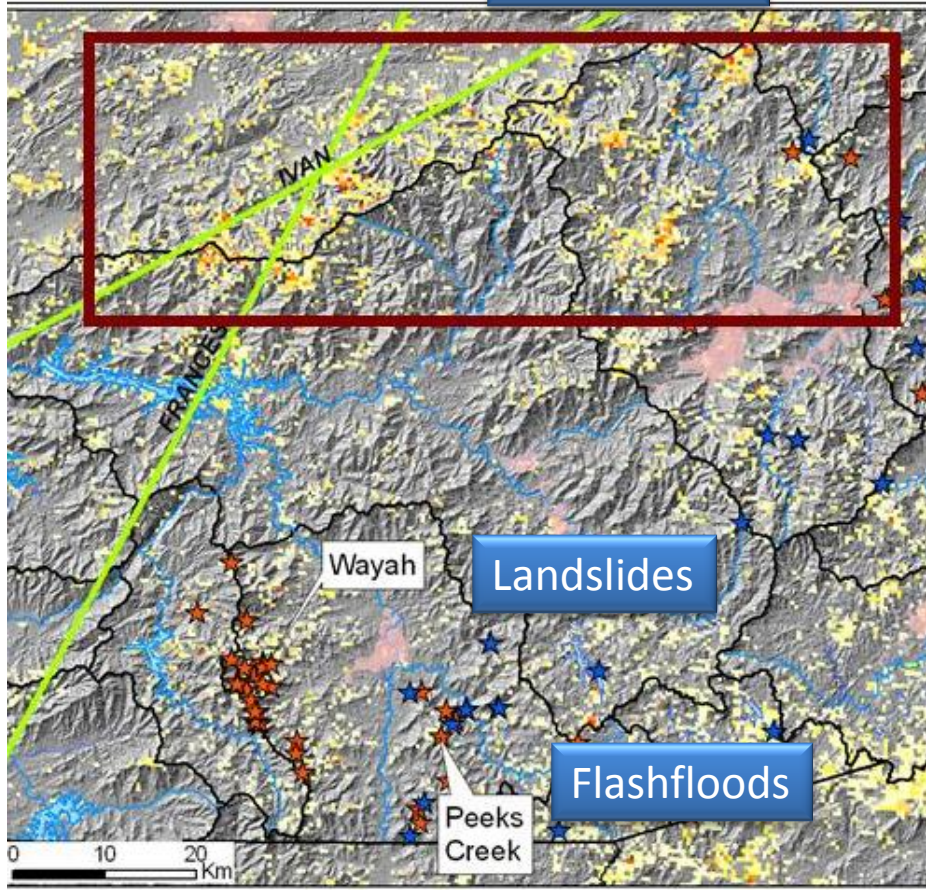
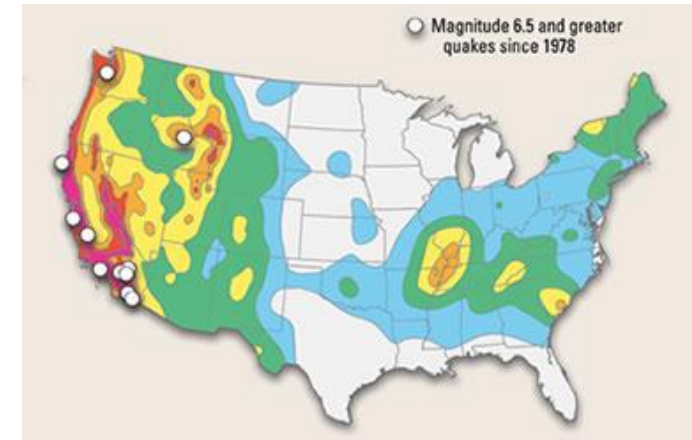
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Covariance of Extremes – Disturbances- Hazards

Spatial Scales < 1 km

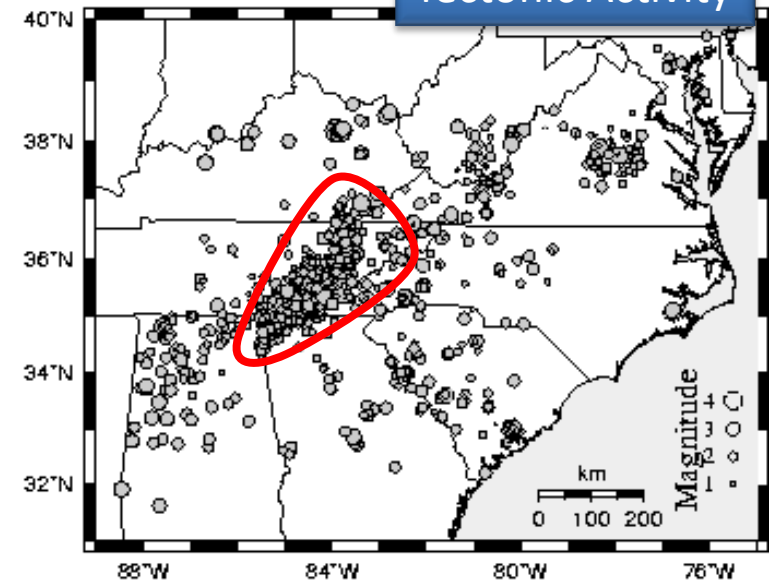


Blow-downs



ETSZ

Tectonic Activity



Brun and Barros 2012